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Strategic analysis of diffusion of renewable energy in the Nordic countries

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A B S T R A C T

Today, there are concerns related to security of energy supply, growing energy demands, limitations of fossil fuels, and threats of disruptive climate changes. To overcome the challenges, diversification and utilization of renewable energy resources are defined as the main strategies. However, successful diffusion of renewable energy requires consideration to many factors including social, economic, and technical ones. Nordic countries are among the leading countries on successful development of renewable energy and energy efficiency. This research, in the frame of a strategic conceptual analysis, studies the policies and achievements of the Nordic region in their development of renewable energy. The framework consists of four layers including dimensions, characters, objectives, and key schemes.

Contents

1. Introduction

Although carbon-based fuels are dominant resources of power generation for residential and industrial needs, they do not offer

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long term and sustainable perspectives. According to the IEA reports, approximately 81% of the world's energy demand was supplied by fossil fuels in 2009 [1]. Since they are not located equally in the world, European countries depend largely on fossil fuels imports from other regions such as Middle East and Russia. Thereby, concerns and challenges (e.g., fluctuating carbon based fuel prices and uncertain oil and gas supplies) exist to have a secure energy supply in Europe. In response, various strategies are suggested and developed by governments and related authorities (e.g., European Union) such as upstream investment in producing countries, utilizing domestic and local natural resources, long-term contracting at premium prices, diversifying fuels and suppliers, decentralized forms of utilization etc. [2]. However today, environmental considerations influence energy security calculations. Therefore, policies like development of renewable alternatives are encouraged to contribute diversification and security of energy supply.

Studies show that the Nordic countries (NCs) including Finland, Sweden, Norway, Denmark, and Iceland are good examples to enhance the level of their energy security indicators [3]. For example, while Sweden, Finland, and Iceland are highly dependent to the fossil fuels, they are among top secure countries from energy supply viewpoint [3]. Further, although Norway is one of the main oil and gas exporters, it has the lowest level of dependency to the fossil fuels on its energy systems. In other words, the NCs have made considerable and successful efforts to improve the diversification strategy of their energy supply with core focus on utilization of renewable energy resources (RER). In 2010, Norway and Iceland are among top 10 renewable electricity producers with 96.6% and 100% of their electricity generation from RERs in the world [4]. Denmark has also one of the highest and fastest growth levels of wind power utilization in the world. Therefore, while NCs have only 0.37% (less than 1%) of the world's population, they stand among the countries with highest contribution to primary energy supply from RERs. Table 1 shows the total electricity generation from RER in the Nordic countries and some selected countries and regions in 2009 [3].

The Nordic region is also playing a leading role in diffusion of renewable energy technologies such as Finland and Sweden in biomass technologies, Norway in hydropower development, Denmark with wind power, and Iceland with geothermal utilization. Therefore, not only investigation on strategic and policy perspectives of renewable energy development in the Nordic region is beneficial, it is also one of the best case studies to be followed by other countries and regions.

This article studies the policies and achievements related to renewable energy utilization in the Nordic region. The aim is to develop a strategic framework to evaluate energy policies and decisions, and provides a structure to analyze the adoption of renewable energy. The article starts with a brief review of energy structure in the NCs. Some important and related statistics are reviewed in that section. Then, an innovative conceptual framework is presented and discussed to show the layers of renewable energy development policies. The layers include dimensions, characters, objectives, and key schemes.

Table 1
Share of RER in the total electricity generation (%) in the Nordic region and some selected cases in 2009 [3,6].

Country or region	Total electricity generation from RER (%)
Finland	31.56
Sweden	58.52
Norway	96.63
Denmark	27.4
Iceland	100
USA	10.5
Germany	20.1
UK	6.18
France	13.34
Belgium	6.53
Nordic average	62.82
Top 33 richest countries based on GDP	23.58
Top 33 richest countries based on GDP (without Nordic countries)	16.51

2. Analytical framework of energy supply in the Nordic countries

The Nordic countries (NCs) are the northernmost countries in Europe. This region includes independent countries (Finland, Sweden, Norway, Denmark, and Iceland) plus three autonomous regions (Aland, Faroe Islands, and Greenland). The population of the NCs was 25,830,631 (0.37% of World) on April 2012 [3]. The region is among top developed countries from economic and social welfare indicators.

The NCs are energy intensive countries because of cold climate, their energy intensive industries, wide sparsely populated areas with long distances, and their high standard of living. For instance, Finland's per capita energy consumption is the highest within European Union [5]. Norway and Sweden are also among top countries in this indicator. Fig. 1 illustrates the primary energy consumption in the NCs by sources in 2009.

According to Fig. 1, Finland and Sweden have the largest diversity in their energy supply compared to other NCs. While Finland, Sweden, and Iceland have to import a substantial part of their fossil fuels, the annual production of energy in Norway is approximately 10 times of the domestic use [7]. Fig. 2 shows and compares the breakdown of final consumption by source in industry sector of the NCs before first economic recession (1970s) and 2009.

Fig. 2 illustrates that the shares of oil and coal in energy supply have been substantially reduced in the last three decades in the NCs, especially in Finland, Sweden, and Denmark (red and violet colors). In Finland, it dropped from 64% in 1973 to 28.7% in 2009. While electricity and district heating system consume the most part of energy supply, RERs are their main supply resources. Fig. 3 illustrates the energy consumption mix for electricity plants, combined heat and power plants (CHP), and heat plants.

Due to geographic situation of the NCs, solar energy is not a priority for economic utilization. However, Iceland derives 84.3% of its primary energy from indigenous RERs (64.1% geothermal and 20.2% hydropower) which cover 100% electricity generation (hydropower: 12279 GW h and geothermal: 4553 GW h in 2009) [8]. Hydropower is also utilized for more than 90% electricity generation in Norway (126,077 GW h in 2009). On the other hand, Finland and

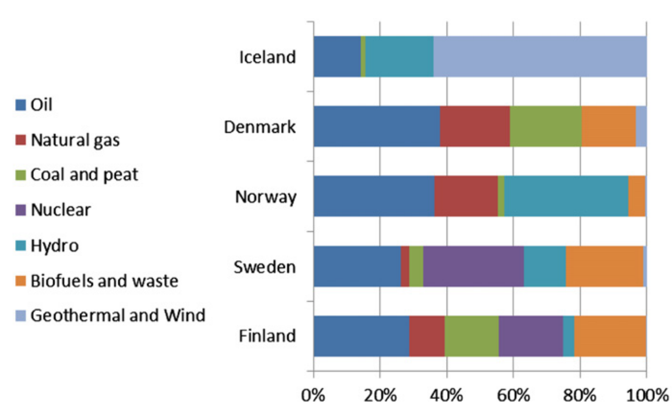


Fig. 1. Primary energy consumption in the Nordic countries in 2009 [6].

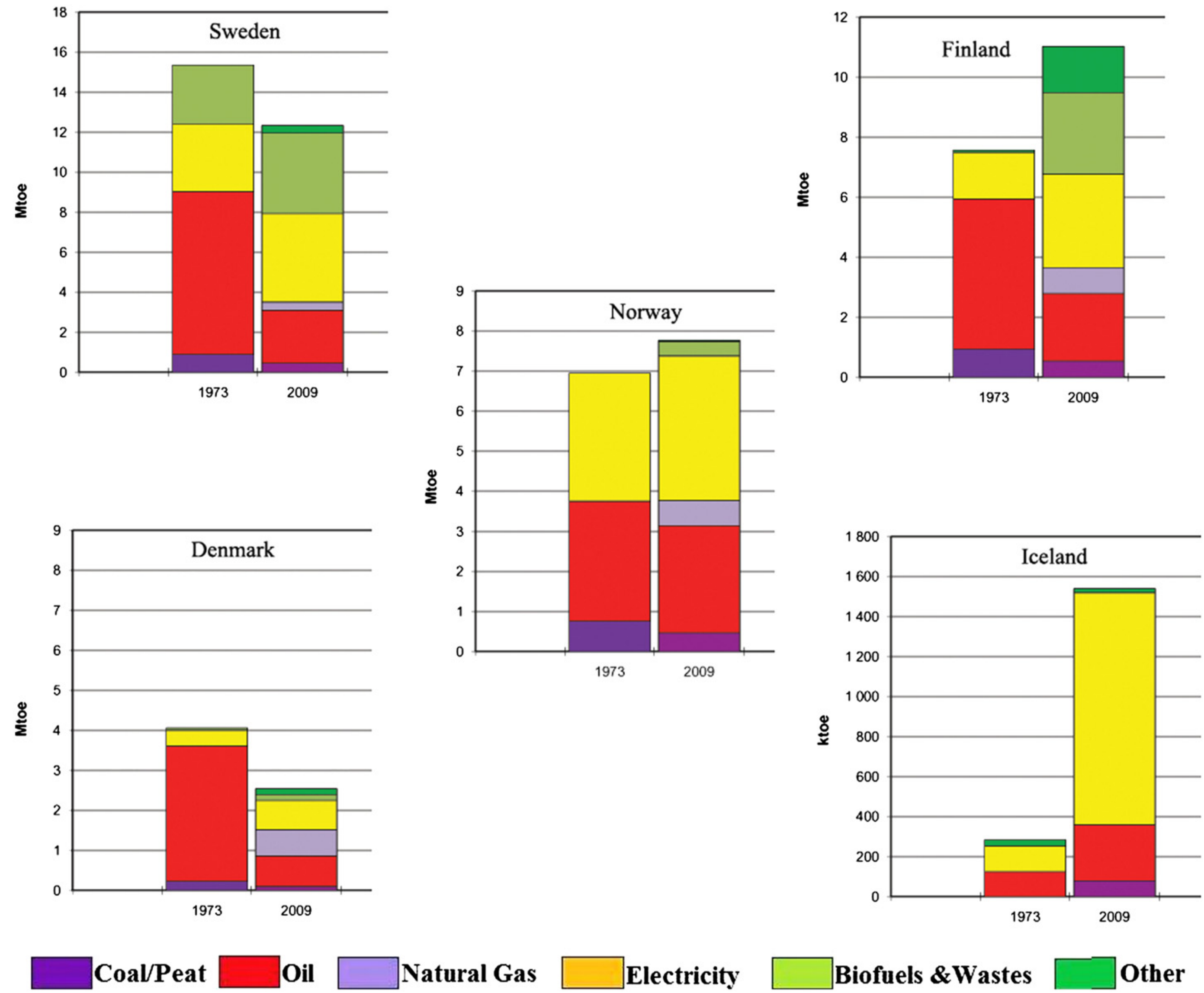


Fig. 2. Breakdown of sectorial final consumption by source in industry sector in the NCs [6].

Sweden are two of the leading bioenergy using countries in the world with 8586 and 11,323 GW h electricity generations in 2009. The national target for Finland is to increase electricity production from biomass in which the major part derives from forest industry [9,43]. In recent years, pellets market is one the rapidly developed industry in Sweden and makes Sweden as one of the world's leading producers and users of pellets in energy supply. Finally, Denmark has a leading role in wind power and the expansion of wind power is an important goal in Danish energy policy and supply.

The above show that the main energy policy of the Nordic governments is to diffuse RE utilization providing different regulations and mechanisms. Table 2 reviews some of the regulations categorized based on country. Next two sections review the strategic and tactic perspectives of the decisions and policies based on a qualitative research.

3. Research methodology

The aim of this research is to understand the strategic aspects of RE development in the NCs. The study helps policy makers and researchers to study how the NCs take action and respond to the challenges of their energy security, and environment by diffusion of RE utilization.

The data come from three primary resources: direct observation of the authors, analysis of statistics reports published by related international agency such as IEA, EIA, European Commission, and scientific references in the fields of energy, investment and management. Approximately 3000 pages of documents and articles include annual reports, detailed government, project reports, and published investigations were reviewed. To organize and extract data and create the conceptual framework, the NVIVO 9(QSR) software was used. The software helped us in three main ways: managing data, managing the ideas, and querying data [10–12]. By analysis of articles, observations, and reports, the authors began to understand how RE has been promoted in the NCs. Therefore, different layers of RE development were identified that play as the barriers or encouragement factors. While some of them have a cultural or a political nature, others have an economic or an environmental structure. Four main layers based on the strategic thinking were defined to categorize each factor: dimensions, characters, objectives, and key schemes. Fig. 4 illustrates the conceptual framework of the analysis.

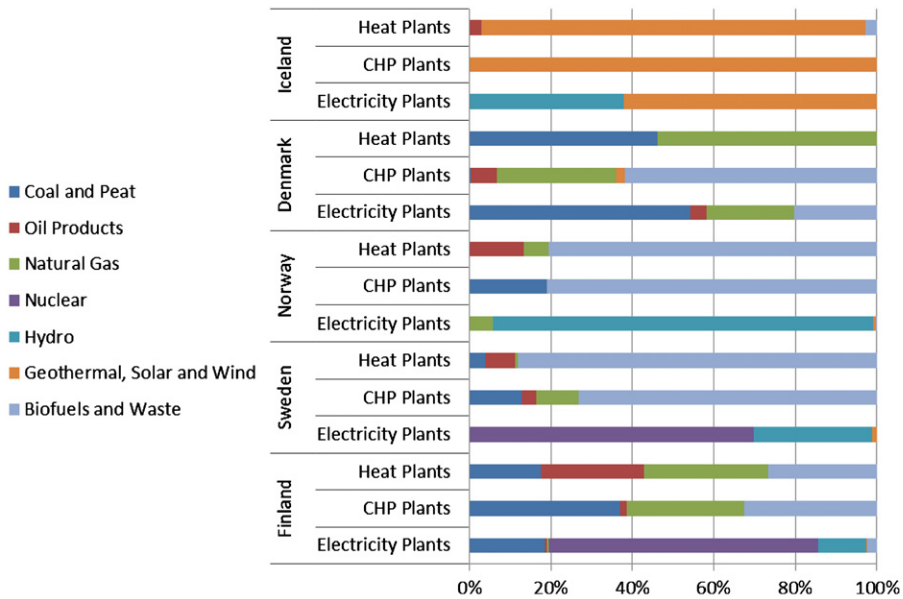


Fig. 3. Energy consumption mix for electricity and heat plants, 2009 [3,6].

Table 2
Some regulations related to RE promotion in the NCs.

Country	Selected regulation plan	Core themes (selected)
Finland	– Long-term Climate and Energy Strategy (2008) – Future—National Strategy to Implement the Kyoto Protocol [39]	• Preserve/improve the diversity of Finland's energy system and the security of energy supply • Increase the volume of indigenous energy sources and their share of total energy consumption during the period 2005–2025 • Increase markedly the share of renewable energy sources (e.g., bio energy) • Import less energy to reduce its percentage of total consumption [40,48]
Sweden	Climate and energy targets by 2020 [41]	• 40% reduction in greenhouse gas emissions. • At least 50% renewable energy. • 20% more efficient energy uses. • At least 10% renewable energy in the transport sector [41].
Norway	– "greenhouse gas emission allowance trading (2004), – White Paper no. 18: security of power supply (2004) [32]	• More pro-active approach to the climate issues. • Increase the installation of small scale hydro power • Secure an effective Nordic power market [32].
Denmark	A Visionary Danish Energy Policy 2025 (2007) [27]	• A minimum 15% reduction in the use of fossil fuels compared with today. • Preventing an overall increase in energy consumption, while sustaining economic growth. With this in mind, the energy saving initiative will be increased to 1.25% annually. • The share of renewable energy must be increased to at least 30% of energy consumption by 2025. • A doubling of publicly funded research and development into and demonstration of energy technology to DKK 1 billion annually from 2010 onwards [27].
Iceland	Climate Change Strategy to reduction of net emissions of greenhouse gases by 50–75% until the year 2050, using 1990 emissions figures as a baseline (2007) [42]	• Greenhouse gas emissions will be reduced, with a special emphasis on reducing the use of fossil fuels in favor of renewable energy sources and climate-friendly fuels. • Attempt to increase carbon sequestration from the atmosphere through afforestation, revegetation, wetland reclamation, and changed land use. • The government will foster research and innovation in fields related to climate change affairs and will promote the exportation of Icelandic expertise in fields related to renewable energy and climate-friendly technology. • The government will prepare for adaptation to climate change [42].

4. Discussion and analysis

4.1. *Dimensions of policy making in renewable energy development in the Nordic region*

A policy is typically described as an idea or plan to guide decisions and achieve rational outcomes. The purposes of strategic decision-making to diffusion of RE in the Nordic region can be summarized in three main dimensions: self-sufficiency, balancing trade-off, and sustainability (Fig. 5).

The first and important aspect of RE development in the NCs is to reduce the consumption of fossil fuels and increase the dependency of indigenous resources (self-sufficiency) [13]. It means low risk for security of energy supply by increasing diversification for oil and coal importers such as Finland, Sweden and Iceland. For instance, while Iceland was one of the poorest European countries during the 20th

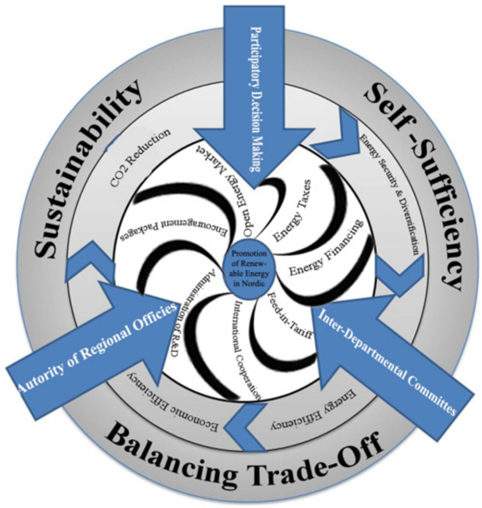


Fig. 4. Conceptual framework of the research.



Fig. 5. Dimensions of policy making in NCs.

century with full dependency to peat and imported coal, today it is a country with a high standard of living in which roughly 85% of primary energy is derived from indigenous RER [3].

Second, as RE is available locally, it helps in economic and technologic growth of the region that brings new job opportunities and social welfare development (balancing trade-off). In other words, RE industry has created new jobs, business and investments, of which many of them are in rural areas of Finland, Sweden, and Norway [12,14]. For instance, more than 200 private entrepreneurs with more than 4000 job opportunities are active in the biomass plants to supply heat to almost 500 locations in Finland [44].

Finally, the reduction in the consumption of carbon-based fuels reduces the pollution and environmental impacts (Environmental sustainability). It is noteworthy; sustainability in this research is covered just one dimension of sustainable development model (environment). Generally, the NCs' programs in controlling carbon emission are among the world's successful plans [15].

4.2. Effective characters on decision making related to RE policies in the Nordic countries

Different groups of stakeholders affect public policies and the process of decision-making [16]. Three main characters influence on promotion plans of RE development in the NCs. They penetrate on the related decisions and policies of the Nordic governments and are completely visible in some key schemes (Section 4.4). Fig. 6 illustrates the main characters influence on decision and policy making in the NCs.

The first character is participatory decision-making. The studies indicate that the successful Nordic policies related to diffusion of RE are supported by community organizations and citizens before implementation [3]. In other words, the public and academic, interest groups, and business sectors are adequately involved in the decision making process, particularly in RE policy formulation [17]. The second character is the role of inter-departmental committees. Inconsistencies decline of government energy policy and execution is the result of this character in RE programs of the NCs. The third character is role and authority of regional offices, universities, and companies in development of RE project. This character increases the role of regional (municipalities) in decision-making and implementation process of RE development in the NCs [18].

4.3. Objectives of diffusion of renewable energy in the Nordic countries

Several policy objectives exist as the sub-groups of policy-making dimensions in the RE development in the Nordic region (Fig. 7). The objectives show different perspectives of diffusion of RE including engineering, social, and management viewpoint and can be broken down into four specific elements (Fig. 7).

4.3.1. Energy security and diversification

Security of energy supply is one of the important debates among citizens and governments of the NCs. In response, diversification is defined as the heart strategy to achieve to a certain level of energy supply. Diversification in energy supply sources can reduce vulnerability of supply disruptions from a particular source. It can also reduce the market power of any one supplier and the risks of higher prices. Studies show that Finland and Sweden have two of the top diversified energy portfolios among other developed countries [3].

4.3.2. Energy efficiency

Energy efficiency means producing specific amount of services using less energy, or maximum output obtained from a given amount of energy resources by keeping resource waste to a minimum [12]. The promotion plans of energy efficiency and conservation in the Nordic region are justified from five

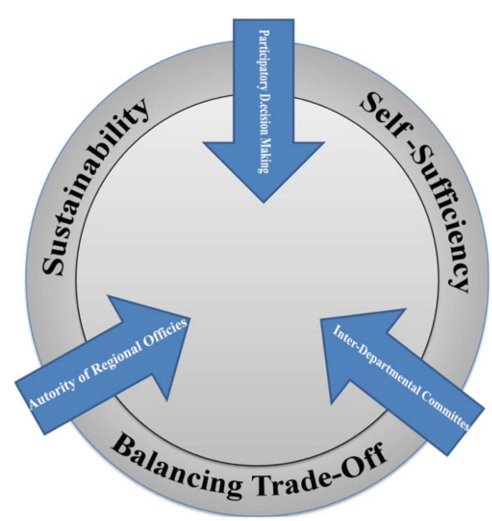


Fig. 6. Characters of policy making in NCs.

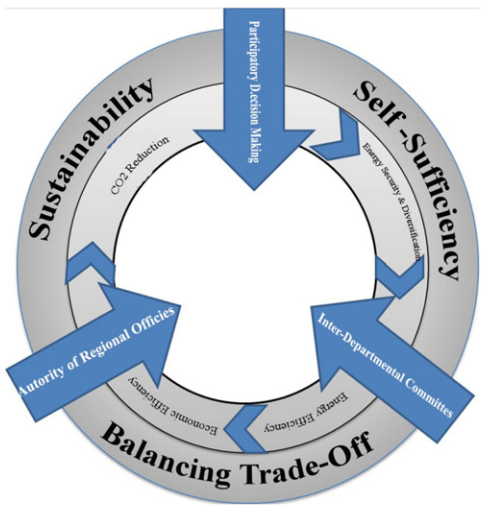


Fig. 7. Objectives of RE policy making in NCs.

viewpoints. First, the NCs especially Finland, Sweden, and Norway are high energy intensive region because of their cold climate. Second, in Finland, Sweden, and Norway the population density is widely sparse with long distances. Third, the energy consumption intensity in the Nordic industries is generally high [43]. For example, the forest and paper industry in Finland alone consume 63% of industrial energy demand [5]. Fourth, the high standard of living in this region causes high energy consumption [3]. Finally, the concerns related to environmental impacts of fossil fuel devices forced to note to energy efficiency. Energy efficiency can be even discussed from energy security and related uncertainties.

The IEA reports imply that the NCs have high energy efficiency. For example, Sweden needed 0.18 toe of primary energy for each USD of gross domestic product (GDP) that is in the efficient region in 2006 [19]. During 2005–2008, the Swedish government introduces subsides which allows to owners of houses to obtain a grant for installation of new windows with a maximum U-value of 1.2. [19]. Resultant decreased energy intensity about 25% averagely in 2008 compared to 1990 in Sweden and Finland [19]. Norway also offers grants for energy savings in homes, buildings, and outdoor equipment areas [20]. Recently, the energy efficiency policies in the NCs are increasingly guided by EU directives and projects.

4.3.3. Economic efficiency

Clough defines economic efficiency as maximizing outputs obtainable from a given set of inputs, or minimizing inputs required obtaining a given set of outputs [21]. Economic efficiency related to the diffusion of renewable energy in the Nordic region consists of two types of efficiency:

- Technical efficiency: Producing a given output at the lowest possible cost due to known technologies and environmental limitations [22]. For example, as Finland has about 150 days winter season, one of the challenges of wind turbines is blades freezing. Operating cost-effective blade-heating system under icing conditions is a good example of this consideration.
- Allocative efficiency: allocating existing stocks of resources and technical knowledge to offer or produce a service or a commodity that buyers value most highly, as indicated by their collective willingness to pay for them. As an example, there are different electricity seller companies in the Nordic countries that offer different kinds of electricity with competitive price (e.g., green electricity or normal electricity) and customers can select and by their electricity.

4.3.4. CO_2 reduction

CO_2 reduction is defined minimizing CO_2 emissions from fossil fuel burning caused by human activities. It is carried out on the demand side as well as on the supply side through efficiency improvement, reducing energy consumption, utilizing some alternative energy technologies, and using a less carbon/cleaner energy [23].

Several efforts have been done related to CO_2 reduction in the NCs. For instance, the Danish government presented the Danish climate strategy for future efforts of climate change in 2003. They have implemented the EU scheme for greenhouse gas emission allowance trading which has regulated CO_2 emissions from January 2005 [24]. In Norway, a law for greenhouse gas emission allowance trading was entered into force in January 2005 along with EU emission trading system [25].

4.4. Key schemes of diffusion of renewable energy in the Nordic countries

To promote the RE utilization, governmental support schemes are essential. These schemes are different and depend on the government policies, resources etc. However, there are common diffusion schemes in the NCs that following are reviewed.

4.4.1. Energy financing

The first and important scheme in the Nordic region is energy financing. It includes direct government investment on the RE technologies and efficiency solutions, supports of private sector investments, financial supports of R&D programs, etc. For example, the Ministry of Trade and Industry Energy Department in Finland grants energy aid for investments in RE sector such as up to 30% government co-financed for construction costs of RE plant [26]. There are also several same finance supports in Sweden and Denmark [20,27]. Norway has lower finance support compared to Finland, Sweden, and Denmark. However, wind power projects can be granted about 25% of the total investment costs for investment support covering in Norway [28]. The Norwegian government also supports maximum 40% of the investments in the heat-processing of biomass program that is aimed at the entire chain from harvesting and transportation to processing and trade with biofuels [7].

4.4.2. Energy taxes

Energy taxes are central instrument of energy and environmental policy among the NCs. Generally, taxes aim to curb the growth of energy consumption and steer the production and use of energy towards alternatives with less emissions (even by subsidies). Nordic's energy tax system is very diverse and comprises many exemptions. It includes different taxes on electricity and fuels, CO_2 emissions, and levy systems on NO_x and sulphur emissions. Taxes are different depending on the fuel is being used for heating or in transport, by manufacturing industry, energy industry or households. Even for electricity, the amount of tax depends upon demands on resource, geographical location, and seasons. Energy taxation scheme in the NCs can be categorized in two parts: tax incentives and subsidies, and taxation.

4.4.2.1. Tax incentives and subsidies. Studies show that the most important scheme to diffusion of RE in the NCs are subsidies and tax incentives. For example, Finland has regulation related to tax subsidies paid for power production based on RERs [29]. Subsides

are between 10% and 30% of the investment costs of the biomass plant [46]. Biomass plants also receive a subsidy per MW h almost equal to the industrial electricity consumption tax.

On the other hand, Denmark has provided subsidies such as defined energy saving measures in buildings and production processes via sale of energy saving certificates to utility companies. This country has also promotion packages (e.g., tax exemption) for hydrogen powered cars [30].

4.4.2.2. Taxation of fossil fuels. The debates among economists show that the best policy instrument to reduce carbon emission is carbon tax [38]. In the Nordic region, tax must be paid for fossil fuels especially for heat production. This policy improves the competitiveness price of bio energy and other resources. As an example, Table 3 shows the Finland's energy taxation introduced by ministry of environment in 2011.

4.4.3. Open energy market

Another main driver of RE promotion in the NCs is open energy market. The goal is to make RE utilization competitive. The Nord Pool Spot and Nordic electricity exchange are two of this open market liberalization (excluding Iceland because of geographical situation). The Nord Pool Spot is one of the first free electric-energy markets in Europe and World and is largest measured in volume traded (TW h) and market share in the world. The Nordic region has also a transparent and fully independent (non-government) network regulator, and most of the power grids are open to all competitors [20].

4.4.4. Encouragement packages and green certificates

The NCs have tried to improve the knowledge and awareness of their citizens about RERs and conservation by development of promotion programs in different levels from the kindergartens to universities. Energy week is one of these promotion programs that are organized annually in different cities of the NCs [31]. Annual campaigns to promote energy savings in buildings are other examples that are organized by the NCs. The role of social media and networks (e.g., TV and Facebook) is also important in the promotion programs. Currently, much attention in Sweden and Norway is directed to the green certificates. In Sweden, certificates are issued to producers of RE and all end-users. The electricity certificate system is one of the main instruments of promoting renewable electricity in Sweden [32]. Under this system, all Swedish electricity generators using eligible technology receive a certificate for each MW h of electricity generated. Eligible technologies are solar, wind, small hydro (up to 1.5 MW) and bioenergy, as well as peat in CHP plants. This policy will continue until 2030 to provide long-term stability for investors [20].

In Norway certificates have integrated with Swedish certificates market. Certificates are also issued for production of wind power, solar power, geothermal energy, bio energy, wave energy, small hydro power, increased production in existing hydro power plants, and new hydro power [32].

4.4.5. Administration of research and innovation and policy instruments

As discussed in Section 4.3, the objective of research and development in the field of energy and RE management is to strengthen economic growth, diffuse use of energy resources and ensure that environmental considerations are taken into account. The competitiveness of RER is also promoted through investment in long-term technology research and development [45]. While most of the overall research funding in the energy sector is provided by public sectors, the results are mostly implemented by private sectors in the NCs.

Most of the R&D funds are allocated to user-driven research programs which increase the competitiveness of energy markets. The most important public or government owned organizations being responsible for administration of R&D, innovation, and policy instruments within RE and energy efficiency in the NC are shown in Table 4 (plus the NCs' universities):

4.4.6. International cooperation

Research show that the NCs involve in cooperation with different international RE projects, especially EU projects. In other words, participation in international cooperation is a main priority and an important supplement to national research efforts in the NCs. Each of the NCs (especially Finland and Sweden) is primarily involved in cooperation within other NCs, EU authorities, and the International Energy Agency (IEA). For example, the Nordic Energy Research Program (NEFP) guides a part of the activities of the former Nordic Energy Research Program [33]. One of the main objectives of NEFP is to develop energy cost-effective reduction of use and development of RERs and related technologies [32]. It is achieved by strengthening collaboration among the universities, colleges and other research institutions as well as developing active research networks in the various levels (national, regional, and international cooperation).

4.4.7. Feed-in-tariff (FIT)

FIT is a mechanism designed to accelerate investment in RE utilization [34]. Although U.S. is the birthplace of FIT, more than 35 countries around the world use this policy in their RE development programs. [12,13,35]. Currently, feed-in tariffs in place provide different types of RE generation facilities a premium payment over a long-term period for each kW h of electricity fed into the grid in the NCs [13].

For example, the Danish policy of FIT is to refund the full CO_2 tax of wind turbines and a partial refund of the energy tax [36]. The distribution companies have to buy all of the electricity produced by wind turbines in the NCs especially in Denmark [37].

5. Conclusion

This study showed how the policies and decisions of RE promotion in the NCs have provided a successful case to be followed by other developed and developing countries. As the

Table 3
Energy taxes in Finland in 2011 [47].

Fuel	Energy tax	CO_2 tax	Security of supply fee	Total
Heavy fuel oil [EUR/t]	87.90	97.2	2.8	187.90
Hard coal [EUR/t]	54.54	72.37	1.18	128.09
Peat [EUR/MW h]	1.90	–	–	1.90
Natural gas [EUR/MW h]	3.0	5.94	0.084	9.024
Pine oil [EUR cents/kg]	0.188	–	–	18.79
Electricity: Tax class I [EUR cents/kW h]	1.69	–	0.013	1.703
Electricity: Tax class II (industrial user) [EUR cents/kW h]	0.69	–	0.013	0.703

Table 4
Most important R&D supporters and policy makers of RE in the NCs.

Number	Country	Institutes
1	Finland	• The Finnish Funding Agency for Technology and Innovation(Tekes) (www.tekes.fi) • Fortum (http://www.fortum.com) • The Ministry of Trade and industry, energy department (www.ktm.fi) • Technical Research Centre of Finland(VTT) (www.vtt.fi) • Motiva (www. Motiva.fi) • The Ministry of Environment, administration of environmental policy (www.vyh.fi)
2	Sweden	• Swedish Research Council (Vetenskapsrådet) (www.vr.se) • Swedish Energy Agency (Statens Energimyndighet) (www.energimyndigheten.se) • the Swedish Agency for Innovation Systems (VINNOVA) (www.vinnova.se) • The Swedish Competition Authority (Konkurrensverket) (www.kkv.se) • The National Board of Housing, Building and Planning (Boverket) (www.boverket.se) • The Swedish Environmental Protection Agency (Naturv · rdsverket) (www.naturvardsverket.se)
3	Norway	• Norwegian Research Council (www.forskningsradet.no) • Enova SF (www.enova.no) • Innovation Norway (www.invanor.no) • The Norwegian Water Resources and Energy Directorate (NVE) (www.nve.no) • Gassnova (www.gassnova.no) • The Norwegian State Housing Bank (The Housing Bank) (www.husbanken.no)
4	Denmark	• Danish Energy Agency (www.ens.dk) • Danish Ministry of the Environment, Environmental Protection Agency (www.mst.dk) • Danish Climate and Energy Ministry, Energinet (www.energinet.dk) • Danish Agency for Science, Technology and Innovation (www.fi.dk) • The Danish National Research Foundation (www.dg.dk)
5	Iceland	• Innovation Iceland (www.nmi.is) • The National Energy Authority (NEA) (www.nea.is) • Iceland GeoSurvey (ÍSOR) (www.geothermal.is) • The Icelandic Regional Development Institute (www.byggdastofnun.is)

result of the complexities of different RERs and technologies, it is impossible to attain successful implementation by a single dimensional approach. A mix of policy is the key driver to increase the installed capacity and energy generation from RE technologies, reductions in cost and price, domestic manufacturing capacity and related jobs and public acceptance. Therefore, a strategic analysis approach was presented to pursue continual RE promotion and shown diffusion layers of RE development in the NCs.

For future research, the authors present their suggestions from two different viewpoints. First from a strategic viewpoint, the dynamic capabilities of RE development programs in the NCs can be described to understand and compare each strategy and policy. The results can be compared by EU projects to identify the current and future opportunities and threats. Second, EU scholars and scholars of other developed or developing countries can implement the introduced framework to compare and get ideas in their case studies. It would help to identify the strengths and weakness of each strategy and policy in selected country or the NCs.

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